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PRELIMINARY RESULTS FROM CYCLE V OF THE CATTLE GERMPLASM EVALUATION PROGRAM AT THE ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER[1]

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INTRODUCTION

Breed differences in performance characteristics are an important genetic resource for improving efficiency of beef production. Diverse breeds are required to exploit heterosis and complementarity through crossbreeding and new composite breeds to match genetic potential with diverse markets, feed resources and climates. Beef producers are under increasing pressure to reduce fat while maintaining or improving tenderness and palatability of products. No single breed excels in all traits of importance to beef production. Previous results have shown that *Bos indicus X Bos taurus* (e.g., Brahman, Sahiwal and Nellore sired F1 cows out of Hereford and Angus dams) crosses were exceptionally productive and efficient cows, especially in a subtropical environment (e.g., Florida versus Nebraska). However, as the proportion *Bos indicus* increased, the advantages of *Bos indicus* crosses were tempered by older age at puberty and reduced meat tenderness. This report presents preliminary results from Cycle V of Germplasm Evaluation Program at the Roman L. Hruska U.S. Meat Animal Research Center (MARC) focusing primarily on characterization of some heavy muscled continental European breeds and some tropically adapted breeds compared to Hereford and Angus sired crosses for characteristics of importance in beef production.

PROCEDURES

The Germplasm Evaluation (GPE) Program has been conducted in five cycles. Table 1 shows the mating plan for each cycle. In Cycle V, as in previous cycles of the program, the base cows included Angus (about 500) and Hereford (about 350) cows calving at 4 years of age or older. In addition, about 550 composite MARC III (1/4 Angus, 1/4 Hereford, 1/4 Pinzgauer and 1/4 Red Poll) cows calving at 4 years of age or older were included in Cycle V. The cows were mated to produce topcrosses by the following sire breeds.

Hereford and Angus. Semen from 20 polled and 11 horned Hereford bulls and from 43 Angus bulls was used to produce F1 cross progeny. Hereford-Angus reciprocal crosses have been used as a reference throughout the GPE Program to facilitate pooling of data and comparison of breeds in different cycles. Twenty of the Hereford bulls (born from 1982-1984) were used in Cycle IV and the remaining 11 bulls (born since 1988) were used for the first time in Cycle V. Twenty seven of the

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Angus bulls (born 1982-1984) were used in Cycle IV and the remaining 16 bulls (born since 1988) were used for the first time in Cycle V.

Tuli. The Tuli, a Sanga type of cattle (non humped), was developed relatively recently in a research program initiated in the 1940's using foundation cattle considered to be the most productive type selected from indigenous Tswana cattle in Zimbabwe. Australian scientists at CSIRO, Tropical Agricultural Research Station, Rockhampton, Queensland, and a consortium of private breeders in Australia imported frozen Tuli embryos from Zimbabwe into Australia in 1990. Semen from nine Tuli bulls was imported from Australia for use in the experiment.

Boran. Borans are a pure Zebu breed (*Bos indicus*, humped) that evolved in southern Ethiopia and are believed to have been developed for milk and meat production under stressful tropical conditions. They were imported into Australia from East Africa (Zambia). Semen from eight Boran bulls was imported from Australia for the experiment.

Brahman. Semen from a current broad sample of 21 Brahman (Grey and Red) bulls (born from 1984-1989, mean birth year 1987) was used to produce F1 progeny. Semen was used from 26 bulls (born from 1964 to 1975, mean birth year 1969) sampled earlier in the program to facilitate pooling of data over cycles and estimate genetic trends.

Belgian Blue. Muscle hyperplasia (double muscling) has been favored for at least 40 years by Belgian Blue breeders in Belgium. Semen from 26 bulls is being used in the experiment.

Piedmontese. Piedmontese originate in the Piedmont region of northern Italy. Muscle hyperplasia has also been emphasized as a criterian of selection in this breed. Seventeen Piedmontese sires included in Cycle IV of the program were repeated to produce one calf crop (1992) in Cycle V.

Calves were produced in the spring of 1992-1994. Each year a sample of about 80 male calves were left intact to evaluate growth and pubertal development of bulls. The remaining male calves were castrated within 24 hours of birth. Calves were creep fed whole oats from mid July until weaning in early October.

Steers. Following a postweaning adjustment period of about 30 days, steers were assigned to replicated pens within sire breed (Hereford and Angus sired steers were treated as a single sire breed) and fed separately by sire breed for an average of 228 days. The growing diet contained about 2.7 Mcal ME/kg dry matter and 12.9% crude protein and the finishing diet fed from about 700 lb to slaughter contained about 3.04 Mcal ME/kg dry matter and 10.9% crude protein. Representative samples of steers were slaughtered serially in 3 slaughter groups spaced 28 days apart in 1993, and 4 slaughter groups spaced about 21 days apart in 1994. The steers were slaughtered in a commercial facility and hot carcass weights were obtained and used to estimate dressing percent (100 X carcass weight/final live weight). After a 24-hour chill, USDA yield grade (fat thickness, longissimus area, estimated % kidney pelvic and heart fat, carcass weight) and quality grade (marbling, maturity) data were obtained. The right side of the carcass was transferred to the meat laboratory at MARC and processed into closely trimmed (8 mm fat thickness) and totally trimmed (0 mm fat thickness) and boneless, retail product (steaks, roasts and lean trim with 20% chemical fat content), fat trim and bone. Retail product, fat trim and bone from the right side was doubled to estimate retail product yield from the carcass. Warner-Bratzler shear force (after 7 and 14 days postmortem aging) and trained sensory panel ratings of tenderness, juiciness and beef flavor intensity (after 7 days postmortem aging) were determined on cooked rib steaks.

Heifers. After weaning and a 42 day adjustment period, heifers were assigned to two pens per sire breed (Hereford and Angus sired females were treated as a single sire breed). In each sire breed, one pen of about 30 heifers was fed a "moderate" energy level and the second pen of about 30 heifers received 80% (as fed) of the feed given to the moderate group. The extra heifers (excess over 60 head per sire breed) were mixed together in two pens and fed the moderate energy level. Heifers were fed a 75% corn silage, 23% alfalfa haylage, and 2% protein mix (as fed) diet containing about 2.34 Mcal ME/kg dry matter and 11.6% crude protein until mid-March and then were fed a 59%

corn silage, 39% alfalfa-haylage, and 2% protein mix (as fed) diet containing about 2.24 Mcal ME/kg dry matter and 12.3% crude protein from mid March until they were moved to grass in early May. Females were checked visually twice daily for estrus beginning on February 1. Surgically altered teaser bulls, rotated weekly, were used to facilitate estrus observation. Weights were taken at 28 day intervals from weaning to the beginning of the breeding period. Heifers were moved to grass pasture in early May, at which time both treatments were combined and run together. Heifers were exposed to Red Poll bulls, for a 63 day breeding season beginning in mid May. Body weights were taken at the beginning and end of the breeding season. Heifers were weighed and pregnancy tested about 65 days after bulls were removed.

Bulls. Following weaning, each year about 80 bull calves were placed in two pens in a drylot, and fed a diet of corn silage, rolled corn and protein-mineral-vitamin supplement (2.69 Mcal ME/kg dry matter, 12.88% crude protein) for 9 months. At 28 day intervals, body weight, hip height, and scrotal circumference were measured. Electroejaculated semen collections were begun when bulls reached a scrotal circumference of 26 cm and continued at 28 day intervals until bulls reached puberty (first produced an ejaculate containing at least 500 x 10^6 sperm with ≥50% progressive motility).

Data Analyses. Preweaning data were analyzed by mixed model procedures using a model that included fixed effects for sire breed, dam breed, age of dam (5, 6-8, 9, ≥ 10 yr), year of birth, sex of calf, sire breed-dam breed, sire breed-sex, and sire breed-birth year and random effects of sire and progeny within sire. Postweaning growth and carcass data on steers were analyzed by least squares procedures using a model that included fixed effects for sire breed, dam breed, age of dam (5, 6-8, 9, ≥ 10 yr), year of birth, sire breed-dam breed, and covariates for age at weaning (mean = 183 d) and days fed postweaning (mean = 258 d). Data on growth and puberty traits of heifers were analyzed by least squares procedures using a model that included fixed effects for sire breed, dam breed, cow age, feeding level, year of birth and two factor interactions for sire breed-dam breed, sire breed-year of birth and sire breed-feeding level. The average least significant difference (LSD .05) among sire breed contrasts is presented for each trait. Differences as large or larger than LSD .05 are expected to result from chance only 5 times out of 100 in experiments of the same magnitude.

PRELIMINARY RESULTS

Breed group means averaged over Angus, Hereford and MARC III dams are shown in Table 2 for preweaning traits. Breed group means for final weight of steers and certain carcass and meat characteristics, adjusted to 441 days of age, are shown in Tables 3, 4, and 5. Breed group means for growth and puberty traits of heifers are shown in Table 6. Breed group means for pubertal development traits of F1 males are shown in Table 7. Breed group means for reproduction and maternal traits of F1 females born in 1992 and mated to produce their first calves by Red Poll sires in 1994 are shown in Table 8. These results are preliminary. Data on postweaning growth and carcass traits of steers and on growth and puberty traits of heifers and bulls are reported and two of three calf crops to be produced in Cycle V of the program. Data on reproduction and maternal performance are especially preliminary, involving first calf production only of females born in only one of three calf crops produced in Cycle V.

Preweaning Traits. Progeny of Boran, Brahman and Tuli sires had longer gestation length than those of Hereford, Angus and Belgian Blue sires. Gestation length was intermediate in length for progeny of Piedmontese sires compared to other breeds. Birth weights were significantly heavier for progeny of current Brahman sires (born since 1988) than for progeny of Brahman sires originally sampled and used in Cycle III of the GPE Program (born prior to 1973). Progeny of Boran sires were lighter in birth weight than progeny of Brahman sires but heavier than progeny of Angus and Tuli sires. Progeny of Piedmontese and Belgian Blue sires were similar in birth weight. Progeny of Hereford sires were heavier at birth than progeny of Angus sires, but neither breed differed significantly

from progeny of Piedmontese or Belgian Blue sires. Progeny of Tuli sires had lighter birth weight than progeny by any other sire breed. In general, calving ease (unassisted calvings, %) was associated with birth weight of the progeny, except that progeny of Belgian Blue sires required relatively more assistance at calving than calves with comparable birth weights by other sire breeds, Progeny of current Brahman sires required significantly more assistance at calving than those of original Brahman sires and progeny of other sire breeds. Considering the relatively heavy birth weights of their progeny, it is somewhat surprising that even higher calving assistance rates were not required for progeny of original and current Brahman sires. Perhaps their shape or conformation helps to offset some of the effects of excessive birth weight.

Survival of calves from birth to weaning was significantly lower in progeny of Brahman sires than in progeny of any other sire breed. Most of the mortality in Brahman sired calves occurred within 72 hr of birth. Survival of calves did not differ significantly among the other sire breeds.

Sire breed groups differed significantly in 200 day weaning weight. Weaning weight tended to be greater in progeny of current Brahman sires born from 1984-1989 than in progeny of original sires born from 1964-1975, but the difference was not significant. Progeny of both Brahman sire groups ranked higher in weaning weight than other sire breeds and were significantly heavier than progeny by Piedmontese, Boran and Tuli sires. Belgian Blue, Angus, and Hereford sired progeny had similar weaning weights, and were significantly heavier than Piedmontese, Boran and Tuli sired progeny at weaning.

Postweaning Steers. Steer progeny of Hereford, Angus and Belgian Blue sires were heavier at slaughter (441 days) than those of Brahman, Piedmontese, Boran, or Tuli sires ($P<.05$). Progeny of current and original Brahman sires did not differ significantly for growth (e.g., final wt = 1164 for progeny of original and 1176 for progeny of current sires) and carcass traits. Thus, results for carcass and meat traits for progeny of Brahman sires will not be presented separately for sires born 1964-75 and sires born 1984-1989 until more data are available from an additional calf crop. Mean marbling score was greater in progeny of Angus, Tuli, Hereford and Boran sires than in progeny of, Brahman, Piedmontese and Belgian Blue sires ($P<.05$). Progeny of Angus, Tuli and Hereford sires graded USDA Choice with a higher frequency than those of Piedmontese, Brahman or Belgian Blue sires ($P<.05$). Shear force and sensory panel estimates of tenderness of longissimus (rib eye) steaks were significantly more favorable for progeny of Belgian Blue, Piedmontese, Angus, Hereford, and Tuli sires than for progeny of Boran or Brahman sires. Sensory panel estimates for juiciness were lower for progeny of Brahman sires than for progeny of other sire breeds.

Mean weight of retail product was greater for progeny of Belgian Blue sires than Piedmontese sires ($P<.05$) which was greater than that of Hereford and Angus sires. Weight of retail product was greater for progeny of Brahman sires, than that of Tuli and Boran sires ($P<.05$). Although live weights of Piedmontese were significantly lighter than those of Angus or Hereford sires, weight of retail product was greater because of their higher dressing percentage and greater percentage of retail product. Mean percentage fat trim was less in progeny of Belgian Blue and Piedmontese sires than in progeny of Brahman sires which was less than that in progeny of Angus, Hereford, Boran or Tuli sires ($P<.05$). Percentage bone for Tuli and Boran progeny was less than that Angus, Hereford and Brahman progeny, which was in turn significantly less than that in Belgian Blue progeny.

Heifers. Mean 365 day weights in heifers were heavier for progeny of Hereford and Angus sires than progeny of all other sire breeds ($P<.05$). Heifer progeny of Belgian Blue sires were heavier than those of Piedmontese sires or progeny of Brahman, Boran or Tuli sires ($P<.05$). Though a trend favored growth rate and fertility traits of females by current Brahman sires over original Brahman sires, differences were not significant for 365-day weight, percentage expressing estrus, or age at puberty. Conception rate was higher for females by current Brahman sires than for females by original Brahman sires. Brahman F1 crosses were significantly heavier than Boran and Tuli F1 crosses. In all breed

groups except Brahman, a high percentage of the females expressed estrus, prior to mid June when estrus observations were discontinued. Mean age at puberty was relatively young for heifer progeny of Piedmontese, Belgian Blue, Hereford and Angus sires, rankings significantly older for progeny of Brahman sires than any other breeds, and intermediate for progeny of Boran and Tuli sires. Breed group means for pregnancy rate of heifers tended to correspond to rankings for age at puberty.

Bulls. Preliminary results for scrotal circumference and age at puberty (i.e., age when bulls produced 500 million sperm per ejaculate with ≥50 progressive motility) are summarized in Table 7. Scrotal circumference at 7 months of age was smallest in Brahman, intermediate in Boran and Belgian Blue, and largest in Tuli and Hereford-Angus sired crosses. Hereford-Angus and Belgian Blue bulls reached puberty earliest, Tuli tended to be intermediate, and Boran and Brahman sired bulls were the oldest at puberty. All bulls reached puberty at 30 to 32 cm scrotal circumference. Brahman and Boran sired bulls were heavier at puberty than Hereford-Angus, Tuli, or Belgian Blue sired bulls.

DISCUSSION

Preliminary results indicate that Belgian Blue and Piedmontese are excellent candidates as terminal sire breeds. Additional data are needed to characterize reproduction and calving traits of backcross and F2 (e.g., Piedmontese-Angus X Piedmontese-Angus) progeny to assess their potential for use in rotational crossing systems or composite populations.

Preliminary results indicate that Tuli cattle, which have evolved in the tropics, produce crossbred progeny with carcass and meat characteristics more similar to progeny sired by British *Bos taurus* breeds (i.e., Hereford and Angus) than to progeny sired by *Bos indicus* breeds (i.e., Brahman or Boran). Cooperative research efforts are in progress to evaluate reproduction and maternal performance of F1 cows by Tuli, Boran and Brahman sires at research stations located in subtropical regions of the U.S. (i.e., Florida, Georgia, Texas, New Mexico and Oklahoma).

TABLE 1. SIRE BREEDS USED IN GERMPLASM EVALUATION PROGRAM AT MARC

Cycle I (1970-72)	Cycle II (1973-74)	Cycle III (1975-76)	Cycle IV (1986-90)	Cycle V (1992-94)
F1 crosses from Hereford or Angus dams (Phase 2)[a]				
Hereford	Hereford	Hereford	Hereford	Hereford
Angus	Angus	Angus	Angus	Angus
Jersey	Red Poll	Brahman	Longhorn	Tuli
S. Devon	Braunvieh	Sahiwal	Salers	Boran
Limousin	Gelbvieh	Pinzgauer	Galloway	Belgian Blue
Simmental	Maine Anjou	Tarentaise	Nellore	Brahman
Charolais	Chianina		Shorthorn	Piedmontese
			Piedmontese	
			Charolais	
			Gelbvieh	
			Pinzgauer	
3-way crosses out of F1 dams (Phase 3)				
Hereford	Hereford			
Angus	Angus			
Brahman	Brangus			
Devon	Santa Gertrudis			
Holstein				

[a]In Cycle V, composite MARC III (1/4 Angus, 1/4 Hereford, 1/4 Pinzgauer and 1/4 Red Poll) cows are also included.

TABLE 2. BREED GROUP MEANS FOR PREWEANING TRAITS OF CALVES PRODUCED IN CYCLE V OF THE GPE PROGRAM
(Three Calf Crops, 1992-1994)

Sire breed of calf	No. calves Born	No. calves Weaned	Gestation length days	Calvings unassisted %	Birth weight lb	Calf surv. %	200-d weight lb
Hereford	334	322	285.7	96.7	94.3	94.7	532
Angus	313	305	283.7	98.0	90.3	99.0	528
Average	647	627	284.7	97.3	92.3	96.9	530
Brahman (orig.)[a]	155	145	292.0	93.0	99.5	91.2	537
Brahman (cur.)[b]	281	260	293.1	88.4	104.6	88.6	545
Boran	456	439	292.4	95.5	95.6	96.3	508
Tuli	491	472	291.0	97.1	85.8	96.3	496
Piedmontese	144	143	289.6	94.7	92.5	98.7	509
Belgian Blue	469	450	284.7	92.8	92.6	95.8	526
LSD .05			1.8	4.2	3.4	3.7	15

[a]Progeny of sires born 1964-1975.
[b]Progeny of sires born 1984-1989.

TABLE 3. BREED GROUP AVERAGES IN FINAL WEIGHT AND CARCASS TRAITS OF STEERS (ADJUSTED TO AVERAGE AGE AT SLAUGHTER OF 440 DAYS)
Cycle V - Phase 2 (Preliminary Data, 1992-93 Calf Crops)

Sire breed of steer	No.	Final wt. lb	Carc. wt. lb	Dress. pct. %	Marb-ling score sc	U.S.D.A. Choice %	Fat thick-ness in	Rib eye area sq in
Hereford	59	1253	747	59.6	518	63.4	.43	11.20
Angus	59	1267	757	59.7	550	82.1	.44	11.39
Average	118	1260	752	59.7	534	72.7	.43	11.30
Brahman	63	1169	711	60.8	477	28.5	.39	11.01
Boran	75	1114	671	60.3	510	53.9	.43	11.24
Tuli	89	1106	675	61.1	531	67.4	.42	11.14
Piedmontese	35	1161	716	61.6	472	28.7	.21	12.84
Belgian Blue	90	1222	755	61.8	459	19.6	.23	12.97
LSD .05		40	26	0.9	24	18.8	.06	0.42

TABLE 4. BREED GROUP AVERAGES IN RETAIL PRODUCT YIELDS OF STEERS
Cycle V - Phase 2 (Preliminary Results, 1992-93 Calf Crops)

Sire breed		.3 in trim		.0 inch trim					
		Retail prod.		Retail prod.		Fat trim		Bone	
of steer	No.	%	lb	%	lb	%	lb	%	lb
Hereford	59	69.0	490	63.3	450	21.9	158	14.8	105
Angus	59	68.9	495	63.2	454	22.3	161	14.5	104
Average	118	69.0	493	63.3	452	22.1	159	14.6	105
Brahman	63	70.1	475	64.4	436	20.9	143	14.6	99
Boran	75	69.5	440	63.7	403	22.6	146	13.6	86
Tuli	89	69.6	442	64.0	406	22.1	141	14.0	89
Piedmontese	35	74.9	502	70.5	472	15.2	104	14.3	96
Belgian Blue	90	74.0	530	69.3	496	15.8	114	15.0	107
LSD .05		1.0	16	1.2	15	1.4	12	.4	4

TABLE 5. BREED GROUP AVERAGES IN MEAT TENDERNESS AND PALATABILITY CHARACTERISTICS OF RIB STEAKS FROM STEERS (ADJUSTED TO AVERAGE AGE AT SLAUGHTER OF 440 DAYS)
Cycle V - Phase 2 (Preliminary Data, 1992-93 Calf Crops)

Sire breed of steer	No.	WB Shear, lb		Sensory panel (7 days aging)[a]		
		7 days aging	14 days aging	Tenderness sc	Flavor sc	Juiciness sc
Hereford	59	13.5	10.6	5.05	4.84	5.22
Angus	59	11.8	8.8	5.48	4.88	5.32
Average	118	12.6	9.7	5.27	4.86	5.27
Brahman	62	17.6	14.3	3.81	4.71	4.78
Boran	76	16.1	12.4	4.33	4.66	5.04
Tuli	89	13.5	10.7	4.83	4.78	5.12
Piedmontese	35	13.0	10.7	4.86	4.79	4.97
Belgian Blue	91	13.7	11.0	4.74	4.77	4.97
LSD.05		1.6	1.2	.41	.14	.16

[a]Scored 1 = extremely tough, bland, or dry through 8 = extremely tender, intense or juicy.

TABLE 6. BREED GROUP MEANS FOR GROWTH AND PUBERTY TRAITS OF HEIFERS
Cycle V - Phase 2 (Preliminary Results, Heifers Born in 1992-93)

Sire breed of female	No.	365-day weight lb.	Puberty expressed %	Age at puberty		Preg. rate %
				Act. d	Adj. d	
Hereford	80	802	97.3	349	351	91.2
Angus	72	799	96.6	346	349	91.3
Average	152	800	96.9	348	350	91.3
Brahman (orig.)[a]	50	718	72.0	406	425	66.9
Brahman (curr)[b]	82	740	80.2	398	412	84.0
Average	132	729	76.1	402	419	75.4
Boran	130	694	90.9	384	391	93.9
Tuli	153	685	93.5	368	374	86.5
Piedmontese	72	712	100.0	337	337	95.4
Belgian Blue	142	761	99.8	339	339	90.1
LSD .05		26	8.3	15	16	11.5

[a]Progeny of sires born 1964-1975.
[b]Progeny of sires born 1984-1989.

TABLE 7. BREED GROUP MEANS FOR GROWTH AND PUBERTAL DEVELOPMENT OF F1 MALES
Cycle V - Phase 2 (Preliminary Results, Bulls Born in 1992)

Sire breed of bull	No.	Scrotal circumference 7 mo cm	Scrotal circumference 12 mo cm	Scrotal circumference 17 mo cm	At puberty[a] Age d	At puberty[a] Weight kg	At puberty[a] Scrot circ. cm
Hereford and Angus Average	18	26.9	33.8	37.5	315.4	424	31.9
Brahman	18	21.8	29.7	35.2	403.9	464	32.1
Boran	14	23.7	30.4	35.4	406.7	464	32.1
Tuli	14	25.4	29.2	34.1	389.3	407	30.4
Belgian Blue	15	24.3	31.7	34.9	324.1	403	30.2
LSD .05		1.6	1.5	1.5	34	43	.9

[a]First ejaculate containing ≥ 500 x 10^6 sperm with ≥ 50% progressive motility.

TABLE 8. BREED GROUP MEANS FOR REPRODUCTION AND MATERNAL TRAITS OF F1 FEMALES MATED TO PRODUCE THEIR FIRST CALVES BY RED POLL SIRES AT TWO YEARS OF AGE
(Cycle V - Phase 3, Preliminary Data, 1994 Calf Crops)

Sire breed of female	Number cows exposed	Number calves born	Calf crop born %	Calf crop weaned %	Unassisted calvings %	Birth weight lb	Survival to weaning %	200-day wt per calf lb	200-day wt per cow exp.
Hereford	31	27	81.5	73.8	71	80.9	91.2	429	315
Angus	24	23	98.6	93.0	92	77.8	99.2	436	404
Average	55	50	90.0	83.4	81	79.4	95.2	433	359
Brahman	67	51	70.9	60.6	80	75.8	91.5	475	294
Boran	57	53	91.5	88.2	71	73.1	97.7	452	399
Tuli	70	58	80.6	74.9	67	74.4	93.2	423	316
Piedmontese	74	65	89.7	80.9	57	80.1	86.6	449	364
Belgian Blue	59	51	85.7	80.4	72	81.1	95.2	448	360
LSD.05			12.7	12.1	23	4.7	14.0	21	67